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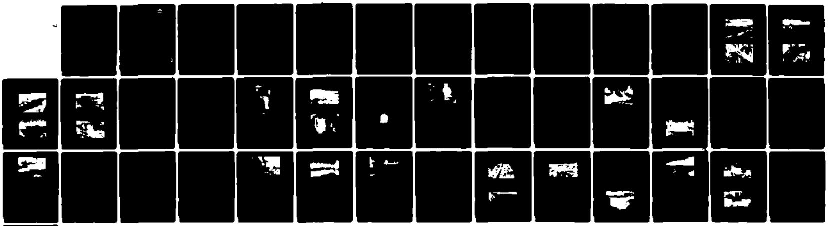

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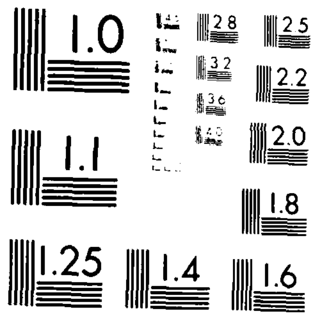

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Special Report 84-10

May 1984

US Army Corps of Engineers
Cold Regions Research & Engineering Laboratory

Observations during BRIMFROST '83

J.R. Bouzoun, F.D. Haynes, R.E. Perham,
K.E. Walker, J.L. Craig and C.M. Collins

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During BRIMFROST '83, a biennial joint training exercise conducted in Alaska by the U.S. Readiness Command, a team from the U.S. Army Cold Regions Research and Engineering Laboratory made several trips into the exercise area to observe and document Army operations in the Arctic. This report presents an overview of the team's observations in the following areas: electrical grounding, camouflage, field fortifications, living shelters, water supply point operations, ice bridges, vehicular mobility and human and solid waste disposal.

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PREFACE

This report was prepared by J.R. Bouzoun, Civil Engineering Research Branch, F.D. Haynes and R.E. Perham, Ice Engineering Research Branch, and K.E. Walker, Applied Research Branch, Experimental Engineering Division; J.L. Craig, CRREL-Alaska; and C.M. Collins, Earth Sciences Branch, Research Division, U.S. Army Cold Regions Research and Engineering Laboratory. Funding for the work performed in support of this report was provided by several work units of DA Project 4A762730AT42, <u>Design, Construction, and Operations Technology for Cold Regions.</u>

John Bouzoun coordinated the preparation and review of this report. The report was technically reviewed by Steven Major and John Stubstad of CRREL.

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J.R. Bouzoun, F.D. Haynes, R.E. Perham,
K.E. Walker, J.L. Craig and C.M. Collins

INTRODUCTION

BRIMFROST is a biennial Joint Forces Arctic training exercise conducted by the U.S. Readiness Command to train soldiers in arctic warfare and to test equipment in arctic conditions. BRIMFROST '83 was conducted throughout Alaska in three phases. First was the deployment and preparation phase, which consisted of deployment of personnel and equipment from a number of CONUS (continental United States) military installations to Alaska and the preparation of roads, ice bridges, airfields, and bivouac sites by engineer units during January 1983. Second was the tactical phase of the exercise from 28 January through 2 February 1983. The third phase consisted of the redeployment of personnel and equipment from Alaska to CONUS during February 1983. Table 1 lists the major Army units which made up the friendly and opposing forces.

The majority of the exercise between the friendly and opposing forces took place in the area between Ft. Wainwright and Ft. Greely in interior Alaska.

Table 1. Major friendly and opposing forces during BRIMFROST '83.

Friendly
172nd Infantry Brigade, Fort Richardson, Alaska
1st Battalion, Princess Patricia Canadian Light Infantry, Alberta, Canada
Opposing
2nd Brigade, 9th Infantry Division, Ft. Lewis, Washington
1st Battalion 509th Infantry, 101st Infantry Division, Ft. Campbell, Kentucky
3rd Battalion 130th Infantry, 47th Infantry Division, Illinois National Guard

During BRIMFROST '83 a team of military and civilian engineers and scientists from CRREL made a number of field trips into the exercise area to observe and document Army operations in the Arctic. The members of the team also provided advice and assistance in their respective areas of expertise to military personnel.

The purpose of this report is to give an overview of the observations made by members of the CRREL team. It is not intended to be an in-depth technical discussion of the observations. In cases where sufficient data were collected and other technical observations made, technical reports will be prepared.

ELECTRICAL GROUNDING

F.D. Haynes

INTRODUCTION

A low resistance electrical ground for field generators in the Arctic is often difficult to obtain because of the high resistance associated with frozen soil. The earth electrode resistance is site specific and highly variable. Soil moisture content and temperature are properties with seasonal variations that can affect electrical ground resistance. Not only does frozen soil have a high resistance to electrical grounding but it also presents formidable problems relating to the emplacement of grounding rods. It is extremely difficult to drive a standard grounding rod with hand tools into frozen soil. In fact a driven depth of 61 cm was the maximum observed during BRIMFROST. While it is possible to drive a rod to this depth in frozen fine-grained soil (silt), it is virtually impossible to drive a rod in frozen coarse-grained soil (gravel). A hole can be drilled if a small- to moderate-sized drill rig is available. However, a small hand-held drill, while most desirable for troop applications, would be usable in frozen silt only. An alternative would be to use shaped charges to blow a hole for the ground rod.

OBSERVATIONS

Field measurements of the electrical grounding of field generators were made during BRIMFROST '83. The measurements were made with a Bison earth resistivity meter, model 2350. The results are given in Table 2. The measured resistance to ground ranged from 677 ohms to 1949 ohms. These are not good grounds when compared to the National Safety Code requirement of 25 ohms or less. The resistance to ground for the test rod driven 30 cm into frozen soil was 1949 ohms. After 1.9 L (0.5 gal.) of saline solution (2.3 kg [5 lb] of salt in 18.9 L [5 gal.] of water) was poured around the rod, the resistance dropped to 1361 ohms. Similar results have been observed and documented by Delaney et al. (1982). The resistance to ground for the test rod driven 61 cm into frozen soil was 681 ohms. After 1.9 L (0.5 gal.) of saline solution was poured around this rod, the resistance only dropped to 677 ohms.

Table 2. Electrical grounding data.

Date	Location	Depth of test rod (cm)	Ground resistivity (ohms)	Initial resistance to ground (ohms)	Resistance to ground after saline solution was applied (ohms)
27 Jan 83	Harding Lake	30.5	92,660	1949	1361
27 Jan 83	Harding Lake	61.0	55,169	681	677

The soil around this rod appeared to be more permeable and possibly allowed the saline solution to percolate away from the rod. One solution in permeable soils is to mix paper (e.g. toilet paper) with the saline solution to form a slurry before pouring. This technique was used by Sellmann et al. (1982) with good results.

RECOMMENDATIONS

Based on the electrical grounding measurements, it is recommended that a saline solution be poured around a grounding rod placed in frozen soil. In addition, if a rod can only be driven 30 to 60 cm into frozen soil, use of multiple rods connected together is recommended.

LITERATURE CITED

Delaney, A.J., P.V. Sellmann and S.A. Arcone (1982) Improving electrical grounding in frozen soils. CRREL Special Report 82-13.

Sellmann, P.V., A.J. Delaney and S.A. Arcone (1982) Electrical grounding in frozen soils. Some additional observations. CRREL Technical Note (unpublished).

CAMOUFLAGE

J.L. Craig

INTRODUCTION

Camouflage is of major importance to any Army since personnel and equipment must be detected in order to be attacked. In the North, their positions may be detected by terrain disturbances, infrared signatures, exhaust signatures, cold-fog and ice-fog signatures, and visible movement.

Because instruments for detecting infrared and other signals were not available during BRIMFROST '83, this section necessarily concentrates on positions detectable or not detectable in visible light.

GENERAL OBSERVATIONS

Aerial observations made during a helicopter flight from Ft. Wainwright to Clear Airfield along the winter trail revealed the high visibility of various positions (Fig. 1). Due to the olive-green colors of uniforms and equipment, uncamouflaged men and materiel could be detected, by sight alone, from several kilometers. Due to environmental constraints none of the observed positions were located in the local stands of spruce. Instead, they were near the edge of spruce stands or in the open.

The least visible positions were those made of, or covered with, snow. In fact, they were nearly impossible to detect from the air. On the ground, these snow-covered positions were, for the most part, not noticeable to the casual observer. Those that were noticeable displayed dark shadows at their entrances. Figures 2-4 are examples of both well-concealed and unconcealed positions.

Some of the best positions were excavated into the snow berm created by clearing the adjacent road with a dozer (see Fig. 7 in the Field Fortifications section). Soldiers reported having slept comfortably in an arctic sleeping bag with a ground pad in these structures. These positions are discussed in more detail in the Field Fortifications section.

Three general problems existed with most of the snow structures. First, the entrances created dark shadows that made the structures more easily de-

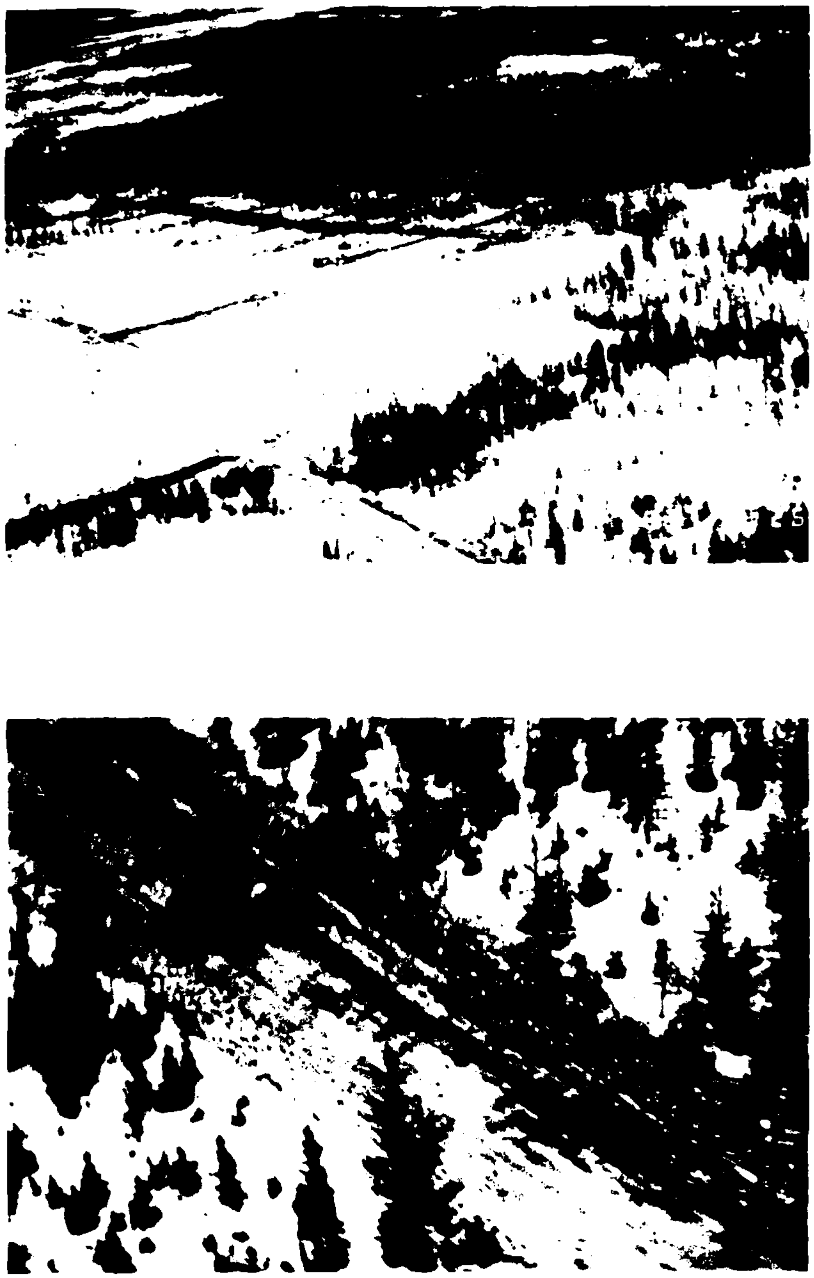


Figure 1. Aerial observations along the winter trail.

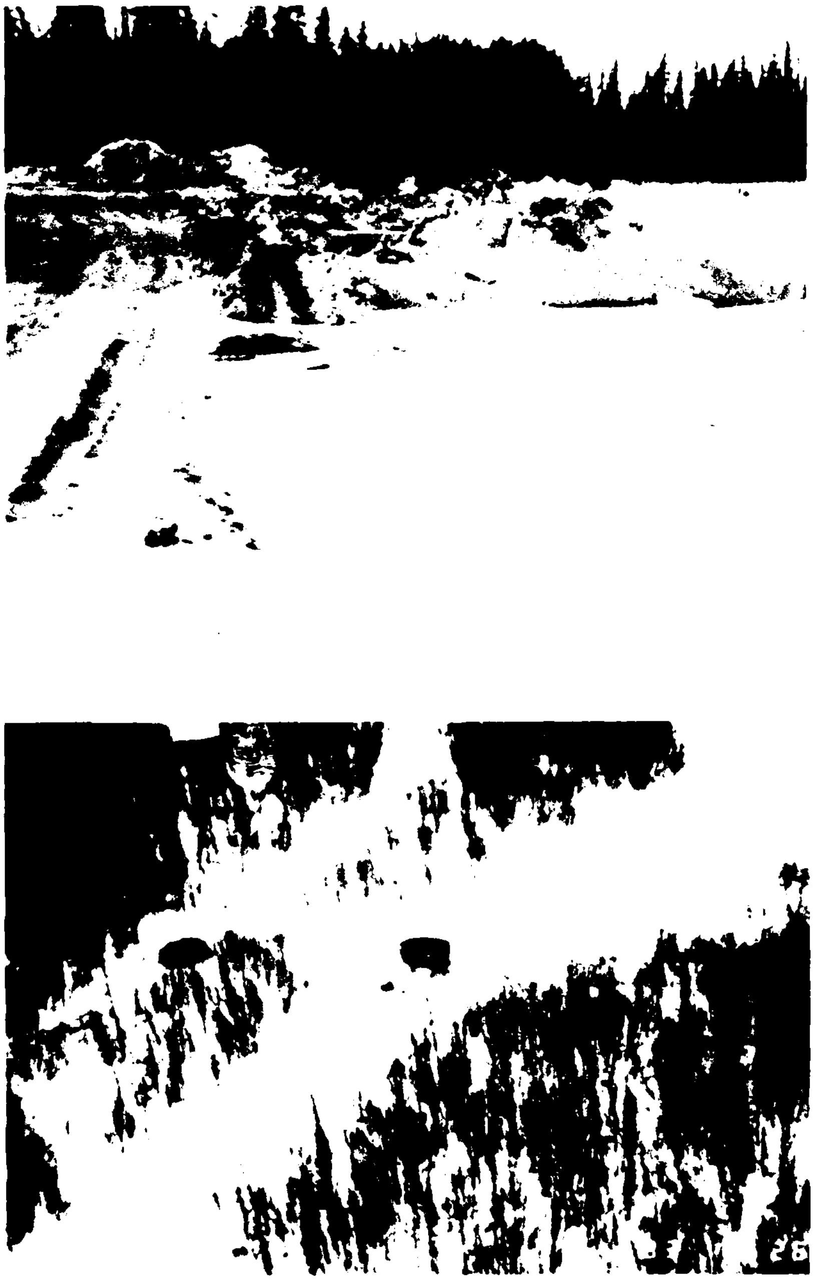


Figure 2. Aerial and ground observations of tents and field fortifications at ice bridge 2.

Figure 3. Aerial and ground observations of tents and personnel at ice bridge 3.

Figure 4. Field fortifications at ice bridge 3.

tected. Second, no loose snow was piled on the snow block structures so that small shadows were created between the snow blocks, giving a rough appearance which contrasted with the smoother snow in the surrounding area. Third, by not filling in the spaces between clumps or blocks of snow, any lights used during darkness could easily be seen outside the structures.

Terrain disturbances give the enemy an indication of the location of positions. Had BRIMFROST '83 not been conducted under environmental constraints, natural vegetation could have been used in order to conceal positions. The scattered spruce stands could have provided extremely good concealment for shelters, while other areas could have been used as decoys.

SUMMARY

Aerial and ground observations were made of several troop positions in order to evaluate the effectiveness of concealment in visible light during BRIMFROST '83. These observations show that snow provided excellent concealment, while colors and terrain disturbances which contrasted with the natural terrain provided little or no concealment. Environmental constraints prevented the full use of local spruce stands, which would have provided excellent additional concealment from visual observation.

FIELD FORTIFICATIONS

J.L. Craig

INTRODUCTION

When men and materiel are detected, they can be attacked with weapons. Field fortifications are necessary to provide protection from these weapons. It has been shown that snow can be used as an effective fortification material (Johnson 1977, Swinzow 1972). This section focuses mainly on observations of field fortifications along the winter trail from Ft. Wainwright to Clear Airfield.

GENERAL OBSERVATIONS

Shelters that could be used as field fortifications are divided into four principal types:

1. Snow-block structures
2. Snow-filled sand bag structures
3. Snow caves
4. Snow tepees

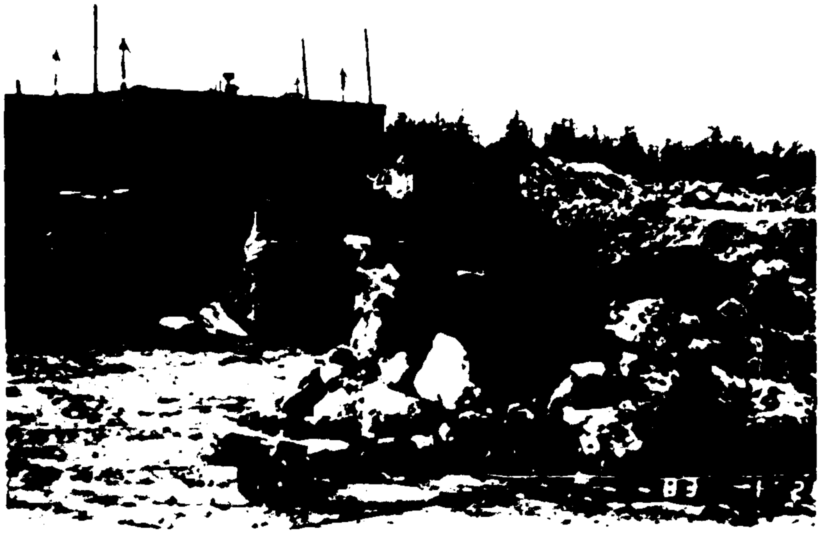
Figure 5 shows a snow block bunker on the south bank of the Tanana River at ice bridge 1. The walls were self-supporting but the roof was built by placing snow chunks on a piece of plywood. The doorway was covered with a tarp. Two serious drawbacks were evident. First, the blocks were not interlocked to provide maximum wall strength; instead, they had been stacked vertically, one directly upon the other. Second, the roof and walls were of insufficient thickness (less than 30 cm) to provide protection from even small arms fire (see Table 3). Excellent protection could have been provided by placing additional snow on and around the structure.

Figure 6 shows two different snow-filled sand bag fortifications. It is assumed that the fortification in Figure 6a, which was located at the Clear Creek Airstrip control tower, was under construction and not complete. This could not be confirmed. The fortification in Figure 6b was located at ice bridge 2. Its walls were made of snow-filled sandbags and an outer layer of

Figure 5. Snow block field fortification at ice bridge 1.

Table 3. Bullet penetration design values, subarctic snow (from Johnson 1977).

Snow type	Density (g/cm^3)	Maximum design penetration (cm)		
		M16	M60	M2HB
Undisturbed	0.18	200	360	----
Piled	0.34	90	170	230
Packed	0.40	70	140	----



a. Fortification at the Clear Creek Airstrip control tower.

b. Fortification at ice bridge 2.

Figure 6. Snow-filled sandbag field fortifications.

snow blocks. The roof consisted of a piece of plywood covered with blocks of snow. The maximum thickness of snow was 1 m at the base. Two improvements could have been made. First, the snow-filled sand bags should have been interlocked to increase the strength of the walls. Second, additional snow should have been added to the structure to provide a minimum thickness of at least 1 m, or as otherwise needed (Table 3). Also, loose snow should have been used to fill between the blocks to eliminate the rough surface texture and therefore decrease detectability.

Figure 7 shows a snow cave about 1 m in diameter × 2.5 m in depth excavated into a snow berm created on the north end of ice bridge 3. The snow was well packed and would have provided good protection from small arms fire on all sides except the entrance. The entrance should have been offset from the main chamber to provide maximum protection. The snow was packed densely enough that excavation of a much larger chamber could have been accomplished.

Figure 7. Entrance to snow cave at ice bridge 3.

Figure 8. Snow tepee at ice bridge 3.

Another structure, a snow-tepee at ice bridge 4 (Fig. 8), had a frame built of poles and limbs lashed together and then covered with pine-boughs. This frame was covered with up to 0.5 m of snow. Again, this structure would not have provided significant protection against small arms fire due to the open entrance and lack of snow thickness. Piling additional snow on the structure to the necessary thickness for protection (Table 3) would have improved the fortification.

SUMMARY

Several structures were briefly evaluated for effectiveness as field fortifications. Three significant weaknesses were noted, with recommended solutions as follows:

1. Snow-filled sand bags and snow-blocks were not interlocked. They should be interlocked to provide maximum structural strength.

2. The depth and thickness of snow were insufficient to provide protection from even small arms fire. Snow should be piled to minimum thicknesses (see Table 3). The spaces between snow-filled sand bags, snow chunks, and snow blocks should also be filled with snow.

3. Open doorways limited the effectiveness of all structures in providing protection. A design providing an entrance offset from the main chamber would greatly improve protection and eliminate shadows.

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LIVING SHELTERS

K.E. Walker

INTRODUCTION

Observations of living shelters used by soldiers during BRIMFROST '83 were made to document information about erecting and using them under cold weather conditions.

OBSERVATIONS

Observations were made of two 10-man arctic tents, each located at separate ice bridge sites along the exercise's winter trail. Both tents were set up on 17 January 83. They were in use by the engineer units tasked with developing, maintaining, and guarding the ice bridges.

Tent 1

Tent 1 was erected adjacent to the winter trail and about 20 m from ice bridge 3 (see Fig. 9). The area had previously been cleared of snow by a bulldozer. It took seven soldiers about one hour to set up the tent and put a Yukon stove together in -25°C temperatures. They briefly tried using gas as a fuel but soon returned to burning wood. Such comments pertaining to use of wood were that "it burns warmer than gas" and "it's quieter." All occupants of this tent slept in their sleeping bags on insulated foam pads.

When gasoline was burned as a fuel, the stove was turned on and off depending on whether the tent was occupied. When the tent was allowed to cool, frost formed on the ceiling and walls, particularly near the seams. Frost was not a problem when wood was burned because the temperature in the tent remained relatively constant. The Yukon stove was set on a metal plate but the ground had thawed in front of the plate. Ponchos were thrown over the thawed area to retain the mud.

Temperatures were taken at various places in the tent at two separate times (see Table 4). The first set of observations was made with a cool stove, as it is normally kept this way during the day with occupants coming

Figure 9. Ten-man arctic tent at ice bridge 3.

Table 4. Temperature observations in the 10-man arctic tent (°C).

Along center pole (Height above ground)	Tent 1 stove (wood) Cool	Stoked-up	Tent 2 stove (gas) Cool
0.3 m	4.4	24.5	5.0
0.9 m	5.7	40.6	13.9
1.2 m	6.6	43.8	18.5
1.8 m	9.2	44.8	23.8
0.3 m in front of stove and 0.3 m above ground	7.2	28.9	18.2
0.3 m above center of stove	8.6	64.0	
0.3 m from far side of tent 3 cm above ground	-1.0	16.7	2.8

Outside temperature -16.8°C

and going. The second set of observations was made with the stove stoked and with the wood rapidly burning.

The only available lantern was not working properly, and as a result, a candle was used for lighting. It was barely bright enough inside the tent to read with difficulty.

Generally a fire guard is on watch at all times, and keeps the fire stoked. The night before observations were made, no guard was kept on and the fire was allowed to die out.

A 0.5-m-high snow wall was formed around three sides of the tent exterior (Fig. 9). The wall was placed about 0.5 m away from the tent to prevent melting. On the side of the tent farthest from the stove, rucksacks were placed between the tent and snow wall to provide insulation. The snow wall helped prevent wind from entering under the tent walls.

Tent 2

This tent was set up adjacent to the winter trail about 35 m from ice bridge 2 (see Fig. 10). The snow in the area had been cleared by a bulldozer. It took eight soldiers approximately 40 minutes to erect the tent in -25°C temperatures. One man had to remove his mittens to tie knots.

The occupants of this tent used gasoline for fuel in the Yukon stove. A 5-gal. tank of gasoline lasted from 14 to 18 hours at -15°C temperatures. No frost problems had been noticed by the occupants.

Figure 10. Ten-man arctic tent at ice bridge 2.

Although no melting of the ground inside the test was observed, floor temperatures on the plywood measured as high as 10.5°C so that melting was probably occurring under the plywood.

Temperatures were taken at various places in the tent (see Table 4).

A lantern hung near the top of the center pole was used for lighting. It was bright enough to read inside the tent with ease.

Cardboard cases of C-rations were stacked up against the stove pipe in this tent. The occupants felt that as long as they were able to touch the boxes there was no danger that the boxes would ignite.

Cut branches were used to prop up the tent ropes before they were pulled tight (Fig. 10). The result was greatly increased head room inside the tent.

Other tents

At another bridge site, a single NCO (non-commissioned officer) was in charge of setting up two tents, one at each end of the bridge. Because he was unable to supervise both, one tent was set up on 0.7 m of loose snow. After the stove in this tent was lighted, it melted down through the snow. When the NCO checked in at this site the tent was flooded. The tent had to be removed and put up, with supervision, in a new location.

At another site, a tent was deliberately set up on 0.5 m of snow. The interior was then shoveled out. As a result the occupants had an additional 0.5 m of headroom in their tent.

CONCLUSIONS

Although each 10-man tent is the same, no two are alike when set up in the field. The most notable observation was a lack of fire control. For example, the tent occupants burning wood felt that a fire guard was not necessary, and in the tent where gasoline was being burned, cardboard boxes were pushed up against the hot stove pipe.

WATER SUPPLY OPERATIONS

J.R. Bouzoun

INTRODUCTION

The danger of dehydration for troops operating under cold weather conditions and over ice and deep snow is a problem that cannot be overemphasized. In addition to providing potable water for consumption by the individual field soldier, water supply points operated in the field by engineer units must provide adequate supplies of safe water for many other uses such as mess hall operations and field hospitals.

The problems associated with setting up and operating a water purification unit in the extreme cold of the Arctic and Subarctic are unique and require ingenuity and a personal commitment on the part of the operators to overcome them. Extreme cold affects the water purification units in two ways. First, equipment such as hoses and pumps will freeze if they are not properly protected while in use or are not drained and stored in warm areas after use. Second, the rate of chemical reactions is drastically reduced in water close to the freezing point.

OBSERVATIONS

During BRIMFROST '83, members of the 23rd and 47th Engineer Companies set up and operated a 1500-gal./hr water purification unit (ERDLATOR) at the Clear Creek Airfield.

The unit was set up approximately 15 m from the west bank of Clear Creek and approximately 30 m upstream of an ice bridge across Clear Creek. A heated maintenance tent was set up perpendicular and adjacent to the purification unit to house the two 1500-gal. water storage tanks and supplies (Fig. 11). The side of the unit opened into the tent. Wooden pallets were placed on the ground in this tent to keep the water storage tanks and other equipment and supplies out of the mud which developed when the ground thawed from the interior heat. The initial thought was to also place the water purification unit in a heated maintenance tent. However, it was realized that the unit's

Figure 11. Water purification unit (1500 gal./hr) at Clear Creek.

leveling jacks would sink unevenly as the soil thawed inside the tent. This, in turn, would cause the clarifier in the unit to become uneven and not function properly. The heat from the abutting water storage tent was sufficient to keep the unit comfortably warm.

The raw water was pumped from a hole cut in the ice in Clear Creek through canvas hose to the purification unit. Because the demand for water was very cyclic (greatest in the morning) and because continuous operation was impaired by freezing of the pump and hoses during periods of extreme cold, the unit was operated on a batch basis. As a result, operators emphasized that it was absolutely necessary to bring the hoses and pump inside the warm tent and drain them, when not in use. If water remained in the pumps and hoses and they were brought back outside in the extreme cold, they would freeze in just the few minutes it took to hook them up. This was particularly true of the electrically powered pump, which, if not properly drained, would lug down due to the formation of ice and trip the circuit breakers on the generator.

The hole in the ice was covered with a piece of scrap wood after each use. Ice would form in this hole between uses and would have to be chopped out with an ice chisel before the hose could be lowered. After this ice was broken apart, it was scooped out of the hole with a shovel so that it would not be sucked into the pump. It was relatively difficult to remove the

pieces of ice from the hole with a shovel because they slipped off the shovel as it was being raised out of the hole. A solution to this problem would be to fabricate a net-type of device out of coarse screening or other rigid open-mesh material and attach it to the end of a stick. If this ice sieve were about half the diameter of the hole, it could be lowered into the hole, under the floating pieces of ice, and then raised to remove them. If coarse screening is not available, a field expedient sieve could be fabricated by weaving small branches from the nearby trees and bushes.

The need to maintain an insulating snow cover near the supply hole in the ice is extremely important. When the hole was first bored, approximately 45 cm of water was under the ice. Within three weeks the ice thickness had increased by approximately 30 cm, leaving only 15 cm of water below it. This ice growth resulted because the snow on top of the ice had been saturated with water from draining the hoses and pumps and had also become icy. In the future, as much care as possible should be taken to prevent saturating the snow. This will maintain the insulating characteristics of the snow and thus help to preserve the original water depth beneath the ice.

Care must be taken to keep the amount of water spilled on the ground around the site to an absolute minimum. A large portion of the area around this site, particularly where the water was dispensed, was covered with a sheet of ice. This was a very hazardous situation, especially near pieces of equipment such as heaters and generators. If this condition cannot be avoided in the future, it is suggested that personnel be assigned to chip the ice with picks to roughen the surface and provide better traction for personnel and vehicles. Goggles must be worn during this operation to protect the eyes from ice fragments.

Since the raw water supply was right at the freezing point, it not only froze quickly but also slowed down the rates of chemical reactions and reduced the solubility of chemicals. The major problem caused by reduced solubility concerned the chlorination of the water. After chlorination with calcium hypochlorite, which was added to the clarifier in granular form, the operators measured a free chlorine residual in the finished water of approximately 5-7 parts per million. After the water had been picked up in 5-gallon cans and allowed to warm up for a few hours in heated tents, however, the smell and taste of chlorine made the water unpalatable. Tests by medical personnel showed that the free chlorine residuals had risen to 14 parts per million. The granular calcium hypochlorite may not have been completely dis-

solved in the cold water and small particles of it may have remained in the water that was dispensed. When the water cans were put inside the heated tents, the remaining particles of calcium hypochlorite may have dissolved and increased the level of chlorine in the water. The operators partially alleviated this problem by adding less calcium hypochlorite to the clarifier. It was suggested to the operators that they make a stock solution of calcium hypochlorite to add to the clarifier as the unit was operating. This procedure would eliminate any undissolved particles of calcium hypochlorite from being dispensed in the finished water.

Since the raw water did not contain any noticeable amount of silt, no chemicals were added to increase coagulation. As a result no sludge was being produced. Any sludge would have been required to be hauled out of the exercise area in accordance with environmental regulations.

It should be mentioned that there was a large demand for water early every morning. This caused a large amount of vehicle congestion at and around the water supply point during a period when enemy activities were most apt to occur. It is suggested that any water containers that can be stored in heated tents, including anything from 5-gallon cans to water trailers, be filled at night. Not only will this reduce the congestion at the site, and thereby reduce the vulnerability of men and equipment to enemy attack, but it will also allow the water to warm up overnight.

CONCLUSIONS

The successful setup and operations of water purification units in the field under extremely cold conditions require that well trained and dedicated operators be available. All pumps and hoses must be totally drained after each use and stored in a warm shelter. Operators must be made aware of the extent to which chemical reactions are reduced in extreme cold and their operational procedures must be adjusted accordingly.

ICE BRIDGES

R.E. Perham

INTRODUCTION

The roads and trails in the exercise area crossed several rivers and creeks. All of these crossings were on ice bridges. In some cases these ice bridges had been built by progressively flooding them with additional water that was pumped onto their surface. In other cases, the streams had frozen naturally to a sufficient thickness so that additional ice was not necessary.

A separate report giving the technical details of each of the ice bridges is being prepared. Therefore, this section will present only an overview of the observations made at a few of the ice bridges.

OBSERVATIONS

At ice bridge 3, which crossed Bear Creek, approximately two-thirds of the bridge was covered with 10 to 15 cm of water on 27 January (Fig. 12). The water reached from the upstream snow berm, which was created when the snow was pushed off the bridge site to accelerate the rate of growth of ice, to the downstream snow berm. The snow upstream of the upstream snow berm was also saturated with water. On the previous day several holes had been drilled through the ice along the upstream edge of the bridge in order to measure the ice thickness. When one of these holes (near the north bank of the creek) was finished, a large volume of water began to flow out of it and flooded the bridge. The bridge was therefore closed to traffic.

At least four explanations could account for the water flow out of the hole and the flooding of the bridge. First, the ice bridge may have been frozen nearly all the way to the streambed, causing a restriction and therefore a backwater upstream. Second, the flooding coincided with a warming trend which may have caused an increase in streamflow. Third, a restriction in the Tanana River, the source of Bear Creek, may have caused an increase in

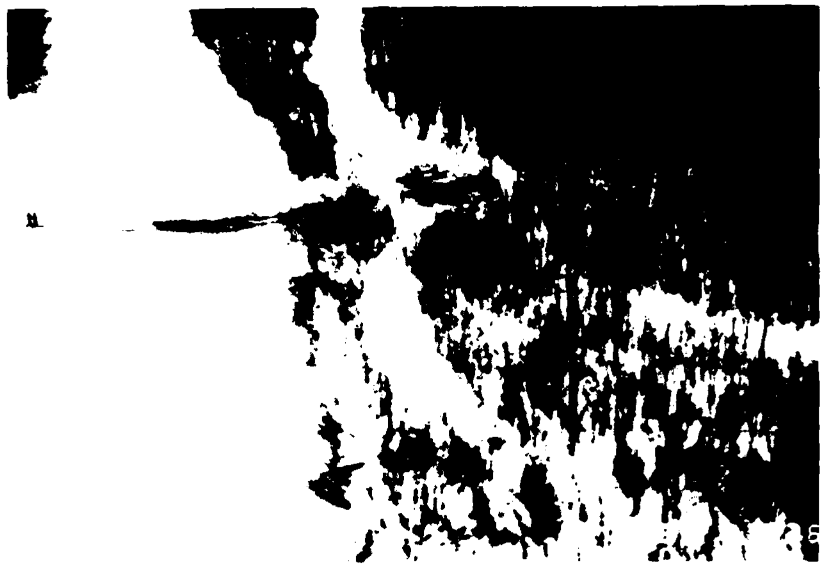

Figure 12. Aerial view of ice bridge 3 (flooded).

the flow into Bear Creek. Fourth, a hot spring type of water outflow was reported about 4 km upstream of the bridge. This may have resulted in warm water temperatures at the bridge site.

In order to reopen the bridge the engineers had originally planned to erect an M4T6 dry span bridge across the entire 30 m width of the creek. Borings along the bridge centerline on the southern third of the bridge, which was not flooded, showed that the creek was frozen solid. As a result of this information, the engineers decided only to span the flooded portion of the creek.

A helicopter carried the preassembled frame for the M4T6 and lowered it into place. A bulldozer nudged the frame into its final position. The deck balk was brought to the site by truck and put in place on the frame by the engineers at the site (Fig. 13). The bridge was three balk lengths long with tapered end balk (ramps) on both ends. The balk stiffeners sat directly on the ice except on the two ends where they rested on sill adapters. As soon as this bridge was in place the road was opened and resupply convoys were allowed to pass.

A different type of problem was encountered at another ice bridge site on the Tanana River. At this site an ice pothole had developed which had made the bridge impassable. When a CRREL engineer arrived at the site, the bridge had been closed and a convoy was waiting to cross it. Apparently a crack had

Figure 13. M4T6 superstructure in place across flooded section of ice bridge 3.

developed perpendicularly to the roadway in the ice that had frozen to the streambed. This crack was most likely caused by the shrinking of the ice as it grew colder and colder. As vehicles passed over this crack, they chipped off more and more of the ice along its edge and their tires threw these chunks of ice out of the hole until the hole was so deep and wide that vehicles could no longer drive through it. Based on the recommendation of the CRREL engineer, a bypass was cleared around the ice pothole with a road grader and the bridge was reopened to traffic.

As stated previously, a technical report about these ice bridges is being prepared that will present detailed technical information about them. However, three general observations that may be of assistance during future BRIMFROST exercises will be given here. First, the ice ramps from the stream banks to the surface of some of the ice bridges were extremely steep. As a result it was necessary for the engineer soldiers to attempt to roughen the surface of the ramps by chipping them with a pick to provide traction (Fig. 14). It is suggested that these river banks be carefully cut down in a manner that will not result in any adverse environmental impact on the rivers. Second, in some cases the roadway paralleled the stream and made a right angle turn onto the bridge. These tight turns were difficult for larger vehicles to drive around and, as a result, restricted the flow of traffic and caused bottlenecks in the vicinity of the bridge. In order to

Figure 14. Roughening the surface of the north ramp of ice bridge 2.

alleviate this problem the roadways should be realigned to provide a straighter approach to the crossing sites. Perhaps this could be done as a training project for the engineer units during the summer before the next BRIMFROST exercise. Third, the engineer units at the bridge sites apparently did not have any ice augers. On several occasions engineer soldiers were observed attempting to make holes through the ice with picks and ice chisels. Consideration should be given to issuing ice augers to engineer units operating in arctic or subarctic regions.

CONCLUSIONS

Observations of ice bridges during BRIMFROST '83 point out the need to develop materiel and doctrine which would allow engineer units to use tactical bridging in lieu of, or in consonance with, existing ice covers on water bodies. Considering the rapidity with which combat forces are expected to move to contact, the time required to increase the thickness of ice by successive flooding and natural freezing will probably not be available. Removal of tactical bridging that has been partially or totally frozen into ice covers will also need to be addressed. Also, it will be necessary to develop expedient methods of camouflaging tactical bridging used in conjunction with ice covers. The use of snow guns to create snow cover over bridging or of whitewash should be investigated.

MOBILITY AND TERRAIN

C.M. Collins

INTRODUCTION

The vast majority of vehicular traffic was confined to the pre-plowed trail system and bivouac areas. Almost all vehicles were wheeled, tactical vehicles. The only tracked vehicles observed were M-113 armored personnel carriers of the Alaska National Guard's 5th Battalion and snowmobiles used by various units.

OBSERVATIONS

Snow conditions were unusual this year, with higher than normal snowfall during the early part of the winter and above-normal snow cover during the exercise period. Snowfall at Fairbanks International Airport, as of 1 February 1983, was approximately 150 cm with approximately 50 cm of snow on the ground. Snow cover in the exercise area averaged near that, but with more variability due to drifting.

Because of the snow cover and the almost exclusive use of wheeled vehicles, plowing of the trail system and encampment areas was carried out prior to the manuever. Snow plowing was mainly done by bulldozers and consisted of clearing snow from the existing trail system and removing snow and vegetation from bivouac areas (Fig. 15).

When the snow was cleared, the dozer blade often cut too deeply, removing snow down to bare ground and stripping off the vegetative cover. Not only does the contrast of bare earth and snow make the cleared areas more noticeable, but the stripping of vegetation can cause unnecessary thaw and erosion problems in permafrost terrain. Figure 16 shows areas on a winter trail plowed down to bare earth.

The Canadians have used "shoes" on the blades of dozers for years for winter trail construction. The shoes keep the blade from removing the vegetative cover and causing excessive surface disturbance in permafrost areas.

Alternatively, rollers or drags have been used to compact snow on winter trails instead of removing it.

Figure 15. Bivouac area prepared by bulldozer.

Figure 16. Areas along the winter trail plowed down to bare earth.

Figure 17. Bivouac area plowed down to bare earth.

Some of the plowed bivouac areas along the winter trail between the Tanana River and Clear Creek appear to be in black spruce terrain that may have ice-rich soil. If so, adverse thawing may occur in these areas this summer. This might have been avoided if the vegetative cover had not been completely stripped away or if the sensitivity of the terrain to disturbance had been recognized and the areas sited elsewhere. Figure 17 shows one of the stripped areas.

CONCLUSIONS

During BRIMFROST '83 a large amount of snow was plowed from the trails and bivouac areas. It is recommended that for future winter training exercises the roads be rolled or dragged in lieu of plowing. If this is not done then shoes should be installed on the dozer blades to prevent excessive surface disturbance in permafrost areas.

HUMAN AND SOLID WASTE DISPOSAL

J.R. Bouzoun

INTRODUCTION

The disposal of human and solid waste during BRIMFROST '83 was a major problem amplified by stringent environmental regulations which essentially required that all waste products be removed from the maneuver area. As a result, an extensive logistics effort had to be implemented to remove the waste products from the area.

OBSERVATIONS

A variety of types of latrines were seen throughout the exercise area. They included holes dug in the snow, folding camp-style toilet seats in makeshift shelters (Fig. 18) and heated tent latrines. With few exceptions, all of these facilities used plastic bags to contain the human waste. When the bags were full they were removed from the latrine, tied closed and stored

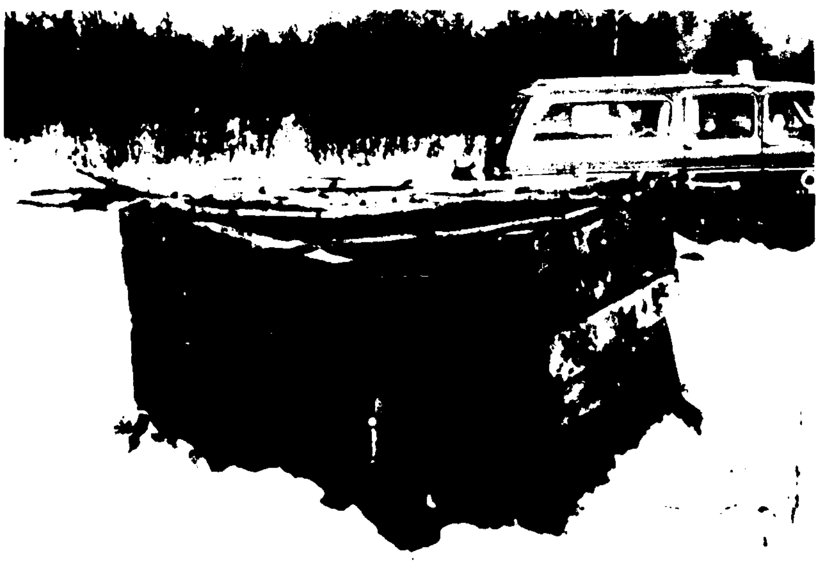

Figure 18. Latrine shelter with folding toilet seat.

Figure 19. Bags of human and solid waste waiting pickup.

outside (Fig. 19). These bags of human waste, as well as bags of combustible solid waste, such as MCI (meal, combat individual) cartons and boxes, were picked up periodically in vehicles and hauled to the closest incinerator where they were burned.

There were five leased incinerators (Fig. 20) located at various locations throughout the exercise area. Two were at the Clear Creek Airstrip, one at Harding Lake, one at Delta Creek, and one at Ft. Greely. The incinerator at Ft. Greely was operated and maintained by a civilian employee of the Facility Engineer's staff. The four other incinerators were operated by military personnel. These oil-fired units required an electric generator for power.

Personnel from Facility Engineering at Ft. Wainwright expressed general dissatisfaction with the incinerators at Clear Creek and Harding Lake. It was their opinion that transporting the incinerators on flat-bed trailers over the bumpy roads had caused some of the operational problems. They also felt that inexperienced operators had contributed to the problem. One of the incinerators at Clear Creek never operated correctly and was replaced by a Dumpster in which combustible materials were burned (Fig. 21).

Personnel from Facility Engineering at Ft. Greely were generally pleased with the incinerator located there during the exercise. This incinerator had not been transported over any extremely rough roads and the civilian operator

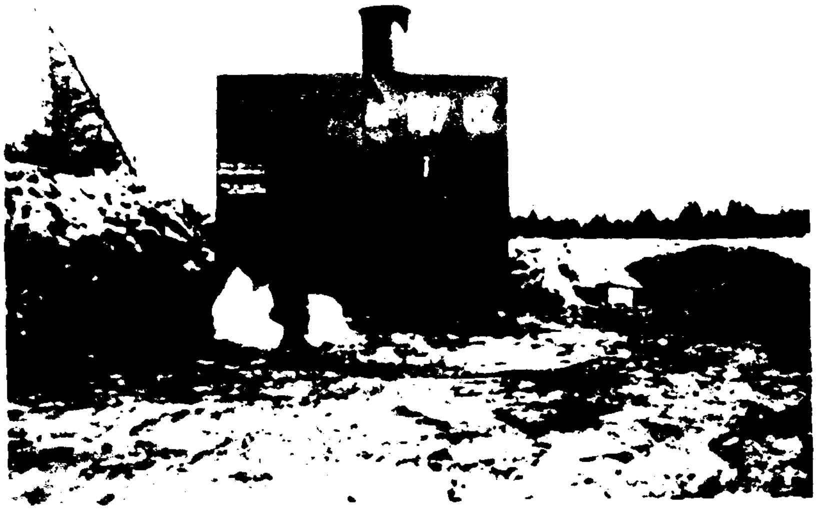

Figure 20. Rented waste incinerator at Clear Creek.

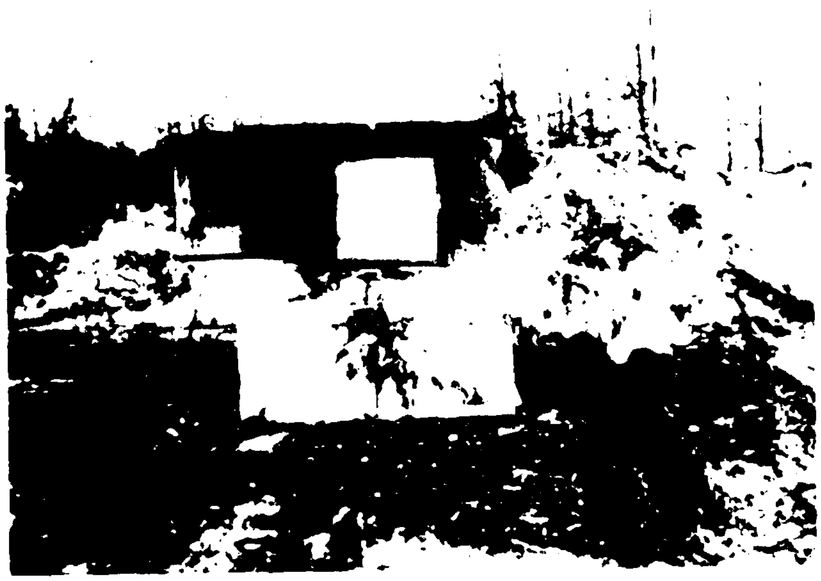

Figure 21. Makeshift Dumpster incinerator at Clear Creek.

had spent a day receiving operational instructions from representatives of the company that provided the incinerators. There was no information available concerning the incinerator located at Delta Creek.

All noncombustible solid waste such as MCI cans were placed in plastic bags which were periodically picked up and hauled back to the landfills at either Ft. Greely or Ft. Wainwright. A significant problem with this procedure resulted not from the weight of these materials but from the volume (bulk) associated with them. A solution to this problem would be to require personnel to crush the cans before they are placed in the plastic bags. It is conservatively estimated that this simple procedure would reduce the volume of this type of waste by more than 75%. This reduction in volume would result in fewer trips to the landfills and in a significantly smaller volume of the landfills being taken up by the waste.

CONCLUSIONS

The major conclusion to be drawn from observations of human and solid waste disposal operations during BRIMFROST '83 is that alternative waste disposal solutions should be evaluated and that an overall waste management plan will have to be developed and implemented for the next BRIMFROST exercise.

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